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Variation in mineral composition and Phytic acid content in different rice varieties during home traditional cooking processes

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Abstract

Study was conducted to find out variation in chemical composition of rice cultivars subjected to common cooking processes by making different products during 2004- 2006. Cultivars were also assessed for their comparative nutrition. Analysis of rice grain showed appreciable amount of sodium (155mg kg^{-1}), zinc (37.5mg kg^{-1}), phosphorus (381 mg kg^{-1}), potassium (1908 mg kg^{-1}) and copper (3.29 mg kg^{-1}). Variation among varieties in respect of nutrients and phytic acid was found non- significant ($P>0.05$). Soaking and boiling processes caused significant ($P<0.05$) decrease in phytic acid, sodium and phosphorus contents in all varieties. Cooking process decreased the concentration of phytic acid, potassium and zinc. Among selected minerals, potassium was found to be highest (1908 mgkg-1). Phosphorus, sodium and zinc were also present in appreciable amounts i.e. 381, 155 and 37.5 mg kg^{-1} respectively. Phytic acid was reduced by 26% due to boiling and 21% due to soaking for 30 minutes.

Key words: Mineral, composition, phytic acid, rice, cooking.

Introduction

Utilization of cereals as food is as old as human history (Orzaez *et al* 1999). They are important sources of nutrients for the population in both developed and developing countries. Shimamato, 1995 reported that rice is one of the most important cereals and half of the world population depends on rice as the main food source. In Asia alone, more than 2000 million people obtain 60-70% of their calories from rice and its by-products (Zhai *et al* 2005). In Pakistan rice is the second largest staple food after wheat and a major foreign exchange earning crop. Rice is a good source of B vitamins, thiamin, riboflavin and niacin but contains little to no vitamin C, D or beta-carotene, the precursor of vitamin A. The amino acid profile of rice is high in glutamic acid and aspartic acid, but slow in lysine (Grist, 1986). Dietary fiber, minerals and B vitamins are highest in the bran and lowest in the aleurone layers. Rice endosperm is rich in carbohydrate and contains a fair amount of digestible protein, composed of an amino acid profile which compares favourable to other grains (Juliano, 1993). Rice also contains some important antinutritional factors, most of which are concentrated in the bran. These include phytate, trypsin inhibitor, oryzacystatin, and haemagglutinin-lectin. All anti nutritional factors in rice except phytin are proteins and denatured by heat (Juliano, 1993). Phytic acid is the hexa phosphoric ester of cyclohexan (Inositol hexa phosphoric acid IP6). It is widely distributed in commonly consumed foods and found in high concentrations in the seed of grains, pulses (Alabaster *et al*, 1996). Fox and Tao, 1989 narrated that phytic acid is usually found as a complex with essential minerals and proteins, and produce an adverse effect on the bioavailability and digestibility of these essential nutrients. It interferes the function of essential nutrients therefore it may be considered a natural antinutrient substance (Patearroyo and Quintela, 1995). Humans have limited ability to absorb and hydrolyse phytate (Pawar and Ingle, 1988). Binding of minerals with phytic acid decrease the bioavailability of Ca, Fe, and P, Zn and other trace elements to human and monogastric animals. This leads to severe nutritional and consequently health problems in the consuming population (Smith and Circle, 1978; Maga, 1982; Thompson. 1987). Iron deficiency anemia (IDA), is a severe problem of public health significance in Pakistan. Quite a large proportion of various population groups are affected (Anon, 1988), resulting in low Hb levels, reduced mental and working capabilities and ultimately in great economic loss (Joseph, 2000). Although, information on phytic acid content of rice is available in literature, very few studies have been documented on the effect of traditional home cooking on the phytic acid content of rice. The present study was undertaken to check the phytic acid content in rice varieties and different rice products. The effect of cooking on nutrients profile and anti nutritional factor will also be assessed.

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Materials and Methods

Materials

Five rice (*Oryza sativa. L)* Cultivars i.e., Swat-1 (S-1), Basmati- 385 (B-385), Dilrosh- 97 (D-97), JP-5 and Fakhr-e- malakand (FkM) obtained from Agricultural Research Institute, Mingora Swat during 2005. The present research work was carried out in the department of Agricultural Chemistry NWFP Agricultural University Peshawar, Agricultural Research Institute Tarnab and Nuclear Institute for Food and Agriculture (NIFA) Tarnab, Peshawar. The samples were thoroughly cleaned, dehusked manually and a composite sample was made from each variety. After grinding, samples were packed in paper bags, and then stored at room temperature for further processing and analytical work.

Each cultivar was soaked and boiled for 30 minutes. Different products like rice kheer and rice bread (Ekmon and Nagodawithana, 1977) were prepared from each cultivar. Treated samples were analyzed for its nutrients retention.

Mineral analysis

Minerals were determined after wet-ashing by concentrated nitric acid and perchloric acid (2:1, v/v). Aliquots were used to estimate Na and K by flame photometry and P by Spectrophotometric methods (Khalil & Manan, 1990). Zn and Cu were determined by Atomic Absorption Spectrophotometry (A.O.A.C., 1990).

Phytic acid

Phytic acid was assessed in cooked and uncooked rice samples according to the method of Hang and Lantzsh (1983).

Statistical analysis

The data, based on three replicates, were subjected to analysis of variance by Complete Randomized Block design with two factors (Steel et al, 1997).). Mans were separated by applying least significant difference (LSD) test at the 5% level of probability (p = 0.05).

Results and discussion

Mineral Composition

Phosphorus

Phosphorus content of rice varieties is shown in table I. In all samples phosphorus ranged from 285-442 mg kg^{-1}. The Analysis of variance showed statistically significant results for phosphorus content in both factors i.e. varieties and products. These finding are in close agreement with that of Hussain (1985) who reported 285 mg kg^{-1} on average whole-wheat flour. Variation in phosphorus content due to boiling was highly significant; suggesting that major portion (about 50%) is solubilized in water during this process.

Table I Phosphorus content (mg kg^{-1}) in five varieties of brown rice and their products

S.No	Varieties/Products	Uncooked	Soaked	Boiled	Kheer	Bread	Mean
1	D-97	424	402	231	333	433	364b
2	B-385	424	404	229	334	433	365b
3	JP-5	442	424	245	351	452	382a
4	S-1	331	327	134	242	342	275c
5	FkM	285	269	193	195	292	226d
Mean		381b	365c	186e	291d	390a	

Means followed by different letter(s) are significantly different at 5% probability level.

Sodium

The data depicted in Table-II showed the mean values for sodium content, which are significantly different ($P<0.05$) for varieties. Uncooked rice contains sodium in the range of 129 to 170 mg kg^{-1}. No significant differences were observed for rice products. These finding are higher than the results by Anjum *et al* (2003) who reported 4.91- 5.36mg/100g in parboiled rice.

Table II Sodium content (mg kg^{-1}) in five varieties of rice and their products

S.No	Varieties/Products	Uncooked	Soaked	Boiled	Kheer	Bread	Mean
1	D-97	129	128	127	127	130	128e
2	B-385	145	143	141	144	146	143d
3	JP-5	163	162	160	163	164	163c
4	S-1	170	166	163	168	171	168a
5	FkM	168	166	161	165	169	166b
Mean		155a	153a	150a	154a	156a	

Means followed by different letter(s) are significantly different at 5% probability level.

Potassium

The results regarding the potassium content of rice and retention of this nutrient during traditional home cooking are shown in Table-III. Potassium was found in highest amount among minerals in rice 1908 mg kg^{-1}. Boiling causes significant decrease in potassium due to its solubility in water during the process. Similar values are recorded in Thai food composition Table (1999), in USDA database (1999).

Table III Potassium content (mg kg^{-1}) in five varieties of brown rice and their products

S.No	Varieties/Products	Uncooked	Soaked	Boiled	Kheer	Bread	Mean
1	D-97	2003	2000	1321	1948	1997	1959b
2	B-385	2017	2015	1220	2007	2002	1853b
3	JP-5	1840	1837	1274	1836	1834	1725c
4	S-1	1729	1725	1427	1723	1719	1665d
5	FkM	1952	1949	1746	1948	1949	1909a
Mean		1908a	1905b	1397e	1892d	1900c	

Means followed by different letter(s) are significantly different at 5% probability level.

Zinc

The data presented in Table-IV regarding the Zinc content of rice reveals no significant difference among rice products. The mean values ranged from 32.6 to 37.5 mg kg^{-1}. It was found that cooking did not cause variation in zinc content of rice.

Table IV Zinc content (mg kg^{-1}) in five varieties of brown rice and their products

S.No	Varieties/Products	Uncooked	Soaked	Boiled	Kheer	Bread	Mean
1	D-97	27.5	25.8	23.7	27.2	27.5	26.38c
2	B-385	28.1	26.8	24.4	27.2	27.6	27.0c
3	JP-5	48.2	46.1	43.0	46.9	48.6	46.59a
4	S-1	34.6	31.1	29.0	34.7	34.5	32.78b
5	FkM	49.1	46.0	43.3	49.2	49.1	47.34a
Mean		37.5a	35.1a	32.6a	37.0a	37.4a	

Means followed by different letter(s) are significantly different at 5% probability level.

Copper

The data presented in Table-V shows the Copper content of rice varieties and its products. Analysis of variance showed that the effect of processing on Copper content in different products of rice varieties was statistically non- significant ($P<0.05$). Similar results are mentioned in USDA nutrition Table (1999).

Table V Copper content (mg kg^{-1}) in five varieties of brown rice and their products

S.No	Varieties/Products	Uncooked	Soaked	Boiled	Kheer	Bread	Mean
1	D-97	3.50	3.10	2.90	3.25	2.95	2.90ab
2	B-385	3.75	3.25	3.0	3.75	3.15	3.38ab
3	JP-5	3.2	2.1	2.0	1.95	1.90	2.24b
4	S-1	3.25	1.55	4.95	7.95	5.25	4.59a
5	FkM	2.75	1.8	1.75	2.25	2.50	2.21b
Mean		3.29a	2.36a	2.93a	3.83a	3.15a	

Means followed by different letter(s) are significantly different at 5% probability level.

Minerals leached into the water at different rates during different cooking treatments. Cooking in boiling water caused a great loss of K (24%) and Fe (8%) (Haytowitz and Matthews, 1983).

Phytic Acid Total phytic acid content was determined in five rice varieties and their products. The data is presented in table VI. On average rice varieties contained 1.51% phytic acid. Boiling and soaking decreased the phytic acid to significant extent.

Table VI Phytic acid content (%) in five varieties of brown rice and their products

S.no	Varieties/Products	Uncooked	Soaked	Boiled	Kheer	Bread	Mean
1	D-97	1.71	1.56	1.28	1.85	1.37	1.35a
2	B-385	1.49	1.59	1.34	1.01	1.24	1.33a
3	JP-5	1.62	1.45	1.18	1.35	1.22	1.36a
4	S-1	1.24	1.73	1.09	1.06	1.31	1.28a
5	FkM	1.52	1.01	1.06	1.02	1.45	1.21a
Mean		1.51a	1.47ab	1.19cd	1.05d	1.32bc	

Means followed by different letter(s) are significantly different at 5% probability level.

Mameesh and Tomar (1993) reported phytate contents in different varieties of uncooked rice ranged between 0.05- 0.22%. When rice was cooked after steeping in excess water and then excess water discarded, 82% decrease is observed in phytic acid content in rice. When rice was cooked without removal of excess water phytic acid concentration decreased only 31%. Toma and Tabekhia (1979) studied the effect of cooking on rice in both domestic tape water and distilled deionized water. The phytic acid in raw rice variety Terso, M-5 and S-6 containing (191.8, 139.6 and 137.1 mg/100g) phytic acid respectively after cooking in distilled deionized water decreased to 187.9, 134.5 and 134.6 mg/100g respectively. Cooking in tape water decreased phytic acid content by approximately 2/3rd in all these varieties (53.7, 44.8 and 41.8 mg/100g) respectively.

Conclusion and Recommendations

From this recent study it can be concluded that rice is a nutritious staple diet, containing most of the essential nutrients and can be utilized to improve nutritional status of a community in developing countries. Traditional home cooking can cause tremendous loss of these essential nutrients, however this cooking can also be adventitious in the sense that it can cause reduction in the amount of phytic acid, an anti-nutrient. Keeping in mind all these factors effecting quality of rice, the following recommendations can be drawn,

- Since rice is a best source of nutrients, therefore care must be taken while preparing different cooked products from it (low temperature treatment).
- Phytic acid an anti- nutrient binds essential nutrients is found in rice, can be reduced in appreciable amount by different home cooking methods i.e. soaking and boiling. However after soaking and boiling of rice, the cooking water should not be discarded as most of the nutrients are leached down in cooking water

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